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AUTHOR Ah Mai, Karen L.
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ABSTRACT

At the conference, which brought together many university representatives from the Pacific Rim, papers were presented yielding both individual problems, perspectives, and successes in computer networks and also group needs and development. In the first section of this report the status reports of networking in the Pacific Rim are summarized. Next comments on technical and policy issues in international network development include a special emphasis on the use of the ARPA Network as a resource in Pacific network experiments and disucss the use of satellites in experiments, the implications of direct broadcasting, and the distinction between "experimental" and "operational" status. A decision on an interim organization was made at the close of the meeting. Included in this report are abstracts of selected preprints and reports. (WH)

# PACIFIC EDUCATIONAL COMPUTER NETWORK STUDY

## RESULTS OF THE SECOND PLANNING AND REVIEW MEETING JANUARY 9, 1974

BY
KAREN AH HAI

U.S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
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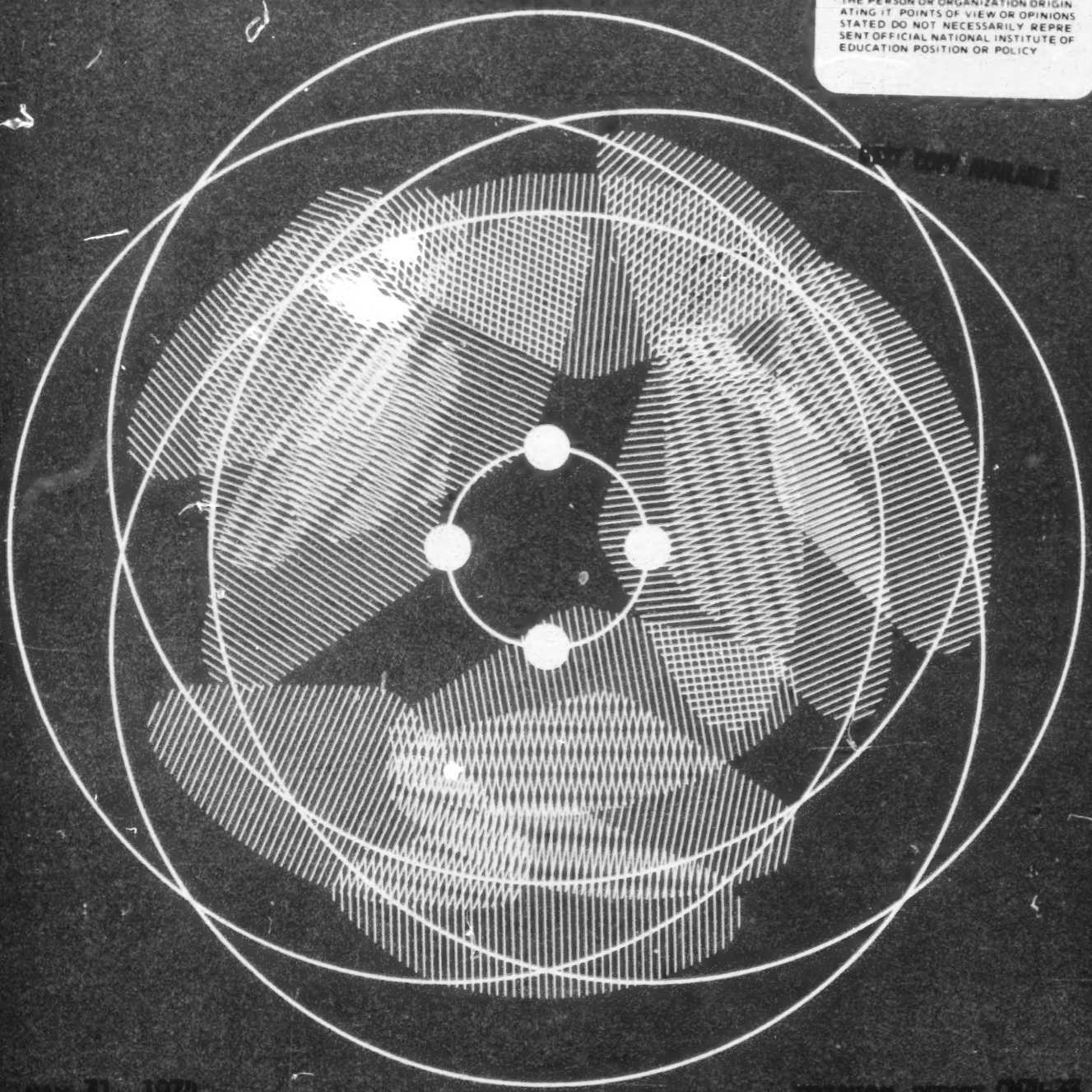

MAY 31, 1974 TECHNICAL REPORT ONA-55

THE ALOHA SYSTEM
UNIVERSITY OF HAWAII
HONOLULU, HAWAII 96822

# PACIFIC EDUCATIONAL COMPUTER NETWORK STUDY

Results of
the Second Planning and Review Meeting
January 9, 1974

by
Karen Ah Mai

May 31, 1974

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## 1. INTRODUCTION

The second planning and review meeting for the Pacific Educational Computer Network experiment was held as part of the Seventh Hawaii International Conference on System Sciences. A special subconference on Computer Nets attracted many papers of interest to the participants in the Pacific network experiment. Many of the institutional status reports given by those present at the planning meeting were extracts from papers presented at this subconference.

A meeting of interested subconference attendees was held to exchange up-to-date information on the networking plans and activities of the various institutions. The session was chaired by Professor John Bennett of the University of Sydney. The group also discussed various technical and policy questions relating to the development of a Pacific Educational Computer Network. Among the topics discussed were: the possibility of connecting the ARPANet to Pacific network nodes; the use of satellites for international data transmission; the implications of the broadcast mode of transmission; and the distinction between "experimental" and "operational" status.

An interim organization for the distribution of information and reports relating to the Pacific experiment was also established.

## 2. THE SECOND PACIFIC EDUCATIONAL COMPUTER NETWORK PLANNING AND REVIEW MEETING: January 9, 1974

### List of Participants

| | | |
|---|---|---|
| 1. | *Chairman:* JOHN BENNETT<br>(Professor, University of Sydney) | University of Sydney<br>Basser Computing Center<br>Sydney, N.S.W. 2006<br>Australia |
| 2. | NORMAN ABRAMSON<br>(Technical Director, ALOHA System) | University of Hawaii<br>The ALOHA System<br>2540 Dole Street, Holmes 486<br>Honolulu, Hawaii 96822 |
| 3. | KAREN AH MAI<br>(Research Associate, ALOHA System) | (same as above) |
| 4. | MANUEL ALBA<br>(Director, Technology and Development Institute, East-West Center) | University of Hawaii<br>East-West Center, Lincoln Hall<br>Technology and Development Institute<br>1777 East-West Road<br>Honolulu, Hawaii 96822 |
| 5. | VINTON CERF<br>(Observer, International Network Working Group) | Digital Systems Laboratory<br>Computer Science and Electrical Engineering<br>Stanford, California 94305 |
| 6. | DIXON T.S. CHEN<br>(Telecommunications Laboratory) | Ministry of Communications<br>Chung-Li, P.O. Box 1<br>Taiwan, Republic of China |
| 7. | HARIJONO DJOJODIHARDJO<br>(Director, Computer Sciences Division) | Institut Teknologi Bandung<br>Jalan Ganesh 10<br>Bandung, Indonesia |
| 8. | HARRY HUSKEY<br>(Consultant, UNESCO) | University of California at Santa Cruz<br>Department of Computer Science<br>Santa Cruz, California 95060 |
| 9. | HIROSHI INOSE<br>(Professor, Tokyo University) | Department of Electronic Engineering<br>University of Tokyo<br>Bunkyo-ku, Tokyo, Japan |
| 10. | ROBERT KAHN<br>(Observer, ARPA) | Advanced Research Projects Agency<br>1400 Wilson Boulevard<br>Arlington, Virginia 22209 |

| | | |
|---|---|---|
| 11. | KENNETH J. KOKJER<br>(University of Alaska) | University of Alaska<br>Electrical Engineering<br>Fairbanks, Alaska 99701 |
| 12. | PAO-HAONG KONG<br>(Director, Telecommunications Laboratories) | 18, Lane 81 Roosevelt Road<br>Sec. 2, Taipei, Taiwan |
| 13. | JI-CHEN MA<br>(Professor, National Taiwan University) | National Taiwan University<br>Department of Electrical Engineering<br>Taipei, Taiwan (107) |
| 14. | SHOICHI NOGUCHI<br>(Professor, Tohoku University) | Research Institute of Electrical<br>Tohoku University<br>Katahira 2-1-1<br>Sendai 980, Japan |
| 15. | JURO OIZUMI<br>(Professor, Tohoku University) | (same as above) |
| 16. | ITTIPON PADUNCHEWIT<br>(Head, Computer Science Laboratory) | Computer Science Laboratory<br>Graduate School<br>Chulalongkorn University<br>Bangkok, Thailand |
| 17. | JAI P. SINGH<br>(SITE Director, India) | Indian Space Research Organization (ISRO)<br>F-Block, CBAB Complex<br>District Office Road<br>Bangalore - 560009<br>India |
| 18. | KI SOO SUNG<br>(Director, Computation Research Laboratory) | Korea Institute of Science and Technology<br>P.O. Box 1313<br>Chyung Ryang<br>Seoul, South Korea |
| 19. | G.A. VIGNAUX<br>(Professor, Victoria University of Wellington) | Victoria University of Wellington<br>Private Bag<br>Wellington, New Zealand |

## 3. STATUS REPORTS OF NETWORKING IN THE PACIFIC

Participants in the second planning and review meeting for Pacific Educational Computer Network activities were welcomed by Dr. Norman Abramson, Technical Director of The ALOHA System. The ALOHA System, a research project in the Department of Electrical Engineering, University of Hawaii, is involved in numerous computer-communications experiments utilizing satellites and radio transmission.

Prof. John Bennett of the University of Sydney chaired the session, which was called (1) to provide the opportunity for individuals interested in international networking to meet each other and (2) to discuss issues pertinent to the formation of a Pacific Educational Computer Network experiment. Following are summaries of remarks made by members of the group regarding the interest, plans, and activities of their respective institutions in the field of computers and networking.

Ittipon Padunchewit, Head of the Computer Science Laboratory, Chulalongkorn University: In computer-oriented education, Chulalongkorn University offers a Master's degree in Computer Science, a Bachelor's degree in Engineering, and a Certificate awarded by the Computer Science Center.

In network-related research, the development of communications systems is just beginning. We have ordered low-speed Mohawk Data Systems terminals and modems and will try to connect to other universities. Hardware construction has just started. We hope to be part of the Pacific network experiment in the second stage of our development, perhaps in 1975.

Harry D. Huskey, United Nations Consultant on Computers in Developing Countries: We were recently involved in a contract between the University of California, UNESCO, and Burma to set up a computer center at Rangoon. There is no activity taking place in this development that is related to joining the Pacific Educational Computer Network.

Jai P. Singh, Director of the SITE Project, Indian Space Research Organization: The participation of India at this stage is doubtful since it is not in the range of ATS-1. A transnational system may be possible after ATS-1 for informational purposes as well as for education. Our current status is that of an observer of the Pacific network experiment.

Harijono Djojodihardjo, Director of the Computer Science Division, Computer Center, Institute of Technology at Bandung: The Institute of Technology has 22 departments, including Electrical Engineering, which is very strong, Mathematics, and Engineering Physics.

The computer center is very new--two years old. It is interdepartmental and its purpose is to introduce computer applications

to the Institute. Regarding the future planning of computer education at the Institute, we have only modest computer capability and resources. Our emphasis is currently on the development of manpower.

The Electrical Engineering group has a microwave laboratory which, in a joint project with Phillips Oil and Stanford, is conducting research to provide education to the remote areas of the country.

We are currently observers, but we would be interested in using the Pacific network if the opportunity exists. We may be able to recommend participation later.

Shoichi Noguchi, Professor, Research Center for Applied Information Sciences, Tohoku University: We are currently involved in two networking projects: (1) to establish a connection between the University of Hawaii and Tohoku University using the ATS-1 satellite and TELEX; and (2) to establish a domestic link between Tohoku University and Tokyo University. Professor Oizumi and Professor Inose will elaborate.

Ki Soo Sung, Director, Computation Research Laboratory, Korea Institute of Science and Technology: The Korea Institute of Science and Technology (KIST) supports computer networking in governmental, educational, and commercial applications.

KIST's CDC CYBER 72 is available to users of the KIST Computer Net through dial-up lines, to the Korean Exchange Bank through leased lines, and to the Ministry of Communications through microwave. A transpacific link via satellite between KIST and Jamesburg, California, was attempted in order to utilize CYBERNET's large linear programming packages, but the attempt was stymied by administrative problems.

At this time, KIST is an interested observer of Pacific network activities and may want to participate when the technology and cost of international networking become feasible.

Vinton Cerf, Stanford University: My official position is that of an observer from the International Networking Working Group, sponsored by IFIPS. I am very interested in the technological issues in the Pacific network experiment and in the policy issues which are cropping up, and I would like to exchange views with the participants of this experiment.

Kenneth Kokjer, University of Alaska: We have recently established transmission with NASA-Ames in California and hope to establish reception very soon. We have a NOVA computer. Hopefully we'll be able to access The ALOHA System simultaneously with NASA-Ames, assuming that the protocol is the same.

Ji-Chen Ma, National Taiwan University: We have a joint project connecting three centers in Taiwan: National Taiwan University, National Chiao-Tung University, and the Telecommunications Laboratories of the Ministry of Communications. Dr. Kong will

explain further.

Pao-Haong Kong, Director, Telecommunications Laboratories, Ministry of Communications, Taiwan: I come as an individual and interested observer.

There are 3 or 4 computer networks existing in Taiwan. There are special systems for the commercial banks and hotels, but public services in data communications are not yet ready. Though 50 Kbps circuits are planned, their use is expensive. Therefore, alternatives for efficient and economical networking were sought.

A microwave system connecting National Taiwan University, National Chiao-Tung University, and the Telecommunications Laboratory was constructed. HP 2000 series computers were used as CPUs on an experimental basis. Packet type data formats and burst random access communication methods used in the ALOHA System design were incorporated here. The radio link is operated in diffraction mode due to terrestrial obstacles.

Through new and cheap transceivers, we expect the computer network to be extended to cover the major centers of educational and scientific research in northern Taiwan.

Robert Kahn, Advanced Research Projects Agency (ARPA): Observer.

Hiroshi Inose, Professor, University of Tokyo: We are involved with Tohoku University in setting up the first link of a Japanese University Computer Network. Estimated time for the completion of this connection is 1975. Professor Oizumi can give more details.

Juro Oizumi, Professor, Tohoku University: Tohoku University is involved in two academic networking projects. One is the implementation of the Japanese University Computer Network. The other is the Tohoku-University of Hawaii satellite-TELEX link.

The goal of the Japanese University Computer Network is to connect the computers of all the seven large regional universities, which currently supply computing power in both timeshared and batch modes. The interconnection of these regional centers will make it possible for the users to share their resources. Access to the computation facilities is available to faculty, graduate students, and engineering students of the universities and colleges in the district. The communications lines for these connections are provided by Nippon Telephone and Telegraph (NTT). Concurrent effort is being given to the development of data bases and information files.

(Note: The following comments were extracted from Fujita, et al, A Japan-Hawaii Computer Net--TELEX and Satellite.)

An experimental connection is being established between Tohoku University and the University of Hawaii. The DOWN link, the transmission from the University of Hawaii to Tohoku, uses the ATS-1 satellite. The reception of the signal is not restricted

by license in Japan but the UP link transmission is. Therefore it is necessary to use TELEX to complete the circuit back to the University of Hawaii. The internal codes used in international TELEX, NTT TELEX, and the University of Hawaii ALOHA System were all different, and these incompatibilities were taken care of by an interfacing mini-computer. Although administrative constraints prohibit full satellite transmission, our main emphasis was the effort in satellite data communications.

Manuel Alba, Director, Technology and Development Institute, East-West Center: I am an observer for the Philippines. The primary contacts in the Philippines for Pacific network activities would be the National Computer Center and the University of the Philippines.

G.A. Vignaux, University of Victoria at Wellington, New Zealand: We have a PEACESAT terminal and propose to convert it into an ALOHA terminal for effective joint use of the equipment.

We have a Burroughs 6700 computer and are anxious to establish connection through ATS-1 with the University of Hawaii and/or universities in Australia. We will be cooperating in these experiments with Wellington Polytechnical, which will be providing the engineering.

John Bennett, Professor, University of Sydney: We have enough funds for the necessary equipment for interconnection with the ALOHA System. We have placed orders for everything we need. Permission has been obtained from the body which controls external communications and our Post Office says that we have the necessary transmitting license. As soon as the necessary arrangements can be completed, we hope to establish communications with other centers.

Summary. In summary, the status of activities related to the Pacific Educational Computer Network experiment is:

(1) The ALOHA System at the University of Hawaii is currently the hub of the effort. It has established connection with the ARPANET, a U.S. computer-communications network which includes more than 40 research and academic institutions, and is in the process of establishing experimental data links via the ATS-1 satellite with several other Pacific area institutions.

(2) The University of Alaska and Tohoku University of Japan have completed or are in the process of completing connections to the ALOHA System.

(3) The University of Sydney and Victoria University at Wellington are in the process of constructing the hardware necessary for future connections.

(4) Institutions in Indonesia, Korea, the Philippines, and Thailand are interested observers but have no plans for participating in the network at this time.

(5) Taiwan and India are out of the range of ATS-1 and have no plans for participation in a Pacific network at this time. Burma has no activities related to networking at this time.

The general interest in the networking experiment was high, but administrative and legal problems were recognized as factors which would definitely constrain the rate and modes of development of such a network. These are discussed more fully in the next section.

## 4. TECHNICAL AND POLICY ISSUES IN INTERNATIONAL NETWORK DEVELOPMENT

This section summarizes the main points of discussions on technical and policy issues which have so far emerged in Pacific network experimental efforts. The major topics were:

(1) The ARPANET as a Resource in Pacific Network Experiments
(2) The Use of Satellites in the Pacific Network Experiment
(3) The Implications of the Broadcast Mode of Transmission
(4) The Distinction between "Experimental" and "Operational" Status

We were fortunate in having the following observers present at the meeting: Dr. Robert Kahn from the Advanced Research Projects Agency (ARPA); Dr. Jai Singh, recently Co-Principal Investigator of Washington University's Program of the Application of Communications Satellites to Education; and Dr. Vinton Cerf from the International Networking Working Group.

In the general discussion, Dr. Abramson, Dr. Kahn, and Dr. Singh served as the principal resource persons for the explanations of issues and background involved in international network development. The discussion indicated very clearly that the technical and policy issues were not easily separable at this stage of the experimentation.

The following section is a condensation and reorganization of the discussions on major issues emerging in Pacific computer network experimentation. The material has been expanded for clarification, edited to reduce repetition, and reorganized to present the subject matter in a related manner. In many cases, knowledge of earlier conference discussions was implicitly assumed. To clarify the issues, brief background statements precede the discussions. Where conclusions were implicit because of earlier conference presentations, summaries are also included.

### (1) The ARPANET as a Resource in Pacific Network Experiments

Background. The ARPANET, a packet-switched, experimental U.S. network, represents a large collection of research-oriented computation and informational resources. Because of its widespread publicity and relatively well-developed base of available resources, it was mentioned as a particularly desirable connection for the Pacific experiment. The ALOHA System is currently connected to the ARPANET and, technically, can provide the necessary link for other nations in the experiment.

Discussion.

How can other nations take advantage of the ARPANET?

Dr. Kahn pointed out that the current ARPA network has links in two European countries. In order to establish these connections, all three countries had to come to agreement on the arrangements. Any additional ARPANET linkages that are made wholly within the United States, e.g., the Hawaii-NASA (Ames)-Alaska connection, are covered by the existing agreements. Any connection involving another nation would require the re-negotiation of the agreements between all of the nations involved.

According to Dr. Kahn, there is currently no way in the near term that any action can take place without separate arrangements for each country and a recurrence of those arrangements for each of the countries internationally represented. This is not to say that ARPA will need specific lists of users, but if the exchanges go to the lengths of multi- multi-circuit drops, then ARPA will have to know who will be using it and for what reason.

The justification for additional requests for ARPANET access is going to be based on specific requirements and specific interests. A small set of users would make it more convenient to justify. These all have to be done individually--there is no way that there can be a blanket approval unless it is part of a common enterprise that ARPA can make difensible to the other countries in Europe.

In Dr. Kahn's opinion, it is very desirable to proceed this way--it keeps ARPA away from having to deal with a bloc which would have to represent dissenting views.

The question of what actually constitutes a connection was also discussed. The ALOHA System will be connected to other nations as well as to the ARPANET by satellite. It was agreed that a Pacific network connection to the ARPANET is technically possible but administratively constrained. The difference between connection and non-connection to the ARPANET can be a matter of a switch for line-based systems, but it is currently undefined for satellite transmission systems, especially those with broadcast capability.

Summary. The availability of the ARPANET to non-U.S. users involves much more than a technical link-up. Besides formal approval for use of the network, separate agreements between each of the nations with interconnections to the ARPANET must be executed. The addition of any other nation to any of the interconnected networks would require another re-execution of the agreements.

(2) The Use of Satellites in the Pacific Network Experiment

Background. The availability of the satellite makes possible an economic and efficient means of data transmission not currently available from the common carriers. The organization of the communications channel can be adapted to the characteristics of data generation to and from the computer and the costs of the channel can be distributed according to actual use rather than according to elapsed time, as they now are. The research for developing the most effective means of communications via satellite was one objective behind the Japan-U.S. efforts, and will continue to be a major technical focus of the Pacific Network experiments.

Discussion.

(2.1) What is the time frame for this network development? What goals do you realistically think can be achieved within this time frame?

Dr. Abramson stated that the experiment started with NASA-Ames and the University of Alaska about a year ago. Realistically, if the experiment is successful and we demonstrate what we think can be done--that is, (1) the very efficient use of bandwidth for computer-communications; (2) the flexible use of bandwidth for computer-communications; and (3) the shared use of bandwidth, with voice, perhaps, operating in complete compatibility with packets over the same channel at the same time--we could convince NASA to allow us to use ATS-1 over the Pacific from a more operational standpoint.

However, with the cost of ground stations going down so rapidly, the leasing of transponders from the common carriers may be quite a reasonable alternative.

Dr. Singh agreed that the use of common carriers might be a particularly good option since the PEACESAT use of the satellite was heavily questioned by the common carriers, who interpreted the situation as lost revenues. NASA is not supposed to hurt private enterprise, and the common carriers' attitude has had an effect.

Prof. Bennett stated that, from the educator's standpoint, PEACESAT voice communication and teleconferencing would simply have not gone on without the facility--there is simply no money in educational institutions to support that kind of activity.

(2.2) Regarding the use of ATS-1, the bilateral use of transponders is being demonstrated. What arrangements have been made for multi-lateral sharing?

Dr. Abramson reported that The ALOHA System has already written to NASA for permission for extended use of ATS-1 for experimentation in data transmission. Tohoku University and the University of Electro-Communications, in Japan, have made requests to NASA for similar, related experimentation. The intent is to use the University of Hawaii as the primary base for testing, using transmissions to and from other countries as experimental options if such are appropriate.

With reference to the frequencies being used on ATS-1, they are non-standard and are also being used by other experimental satellites. The Pacific network experiments, however, are based on a low-duty cycle and if our estimate of channel usage is correct, we should barely be noticed in joint use of the allocated frequencies.

Summary. Because of its availability, ATS-1 is the satellite currently being used in Pacific Network experimentation. While it is not ideal, it provides the facility for the preliminary testing of new concepts. For the future, other options, e.g., the joint leasing of channels from the common carriers, may be better solutions.

## (3) The Implications of Direct Broadcasting

Background. The generally used mode of transmission using satellites is "point-to-point", in which the signal is sent from earth station to satellite to earth station and then subsequently delivered through a system of terrestrial broadcast facilities. The broadcast mode would instead transmit signals directly from the satellite to a large number of smaller, cheaper ground stations, each capable of receiving, and possibly, transmitting signals.

When a satellite is operating in broadcast mode, any ground station with sufficient capability can pick up its signals. In general, anyone can receive, but without a license, they cannot broadcast on a frequency not allocated to them. Network-wide broadcasting is a central concept in The ALOHA System's burst, random access method of channel utilization.

Discussion.

(3.1) What about symmetrical transmission from the ALOHA link?

Dr. Abramson explained that theoretically, when the University of Alaska accesses NASA-Ames, they will have access to the ARPANET. Therefore, when they use ATS-1 in their experiment, which will go on shortly, and the ARPANET broadcasts back to them, the output from the ARPANET will theoretically be receivable from the station that Professor Oizumi is setting up in Japan.

However, when a foreign connection, one which is not part of the U.S., is defined on ATS-1 it becomes part of the same domain as the other connections in the international circuit and it was Dr. Kahn's opinion that ARPA cannot allow this kind of connection.

(3.2) What constitutes a "connection" under such circumstances?

Technically, the ALOHA System has use of ATS-1 for only a limited number of hours each day. Its current connection to the ARPANET is not through ATS-1 but through a leased common carrier channel.

Dr. Abramson emphasized that ALOHA communications with Japan may or may not coincide with the University of Alaska time slot allocation. If they do not, there is a possible, but not actual, connection. If they do, arrangements can be made to avoid the actual connection, which is in one-way broadcast mode, not interactive mode.

In Dr. Kahn's view, this is not an atypical situation and, because this type of connection cannot be prevented by administrative means, it cannot be offered as a commercial venture.

Dr. Singh also pointed out that, with regard to establishing connections, the licensing policies of the various countries are different. In the U.S., a license to receive is not required. Australia, India, and other countries require licenses for reception. Therefore, in setting up the network, the licensing policies of the various countries have to be taken into consideration.

(3.3) Regarding the UH-Japan link--will this place the UH in any jeopardy with regard to its ARPANET connection?

Dr. Abramson commented that, as long as the two were kept separate, we would not disturb ARPA in the technical sense. (Note: There are currently plans to place the ATS-1 connection and the ARPANET connection on separate control minicomputers within The ALOHA System to minimize the problem of unintentional access).

(3.4) Is there any policy developing in international telecommunications related to Pacific network experimentation?

Dr. Kahn addressed the legal problem involving ARPA. He stressed that it was their objective to work out questions of this sort but that these problems are ponderous and heavy. The outcome is unpredictable because each country sees things from a different perspective. There does not seem to be a developing pattern for the formulation of these international agreements.

Telecommunications policy is slowly developing in this area but we should recognize that regulatory agencies have been very slow to accept and allow new technologies to be implemented.

Dr. Singh commented that about nine months ago, there was a debate in the United Nations on broadcasting. Russia advocated that broadcasting from nation states be outlawed except in the country where the signal originated. All countries except the United States supported the Russian viewpoint of opposing broadcasting.

Dr. Kahn pointed out that, even though the capability to broadcast is there, the next generation of satellites will be much more directed for more effective power transmission. The trend of satellite development will evolve to the point that wide area broadcasting will no longer be an effective means of transmission. Instead, directed beams will determine precisely what geographic areas will be able to receive the signals.

Summary. Legally, policies for international networking have been slow to evolve and the only current method of securing agreements is by individually executed agreements between the participants. Politically, the attitude toward widespread direct broadcasting from satellites is overwhelmingly negative in the United Nations. The implication for the Pacific network experiments is that the administrative issues may take much longer to resolve than the technical issues.

(4) The Distinction between "Experimental" and "Operational" Status

Background. The use of ATS-1 for computer-communications experiments introduces possible problems with the common carriers. The U.S. National Aeronautics and Space Administration (NASA) currently has authority over ATS-1. As long as the satellite is not being used in competition with commercially available services, no administrative problems emerge. Conceivably, if the Pacific network experimentation is successful and plans beyond small-scale testing are developed, the difference between what is experimental and what is operational has to be considered.

Discussion.

(4.1) How can the ATS-1 experiments be moved to operational status? Some of the nations represented are not interested in ATS-1 experimentation because the satellite cannot be accessed by them, but they would certainly be interested in a more operational arrangement.

Dr. Abramson agreed that, undoubtedly, ATS-1 is not in the best position for Pacific Network development. The experiments on this satellite, however, are valuable in that (1) we are gaining experience in the use of satellites, and (2) we can demonstrate new concepts of networking.

Prof. Bennett added that the only reason that such use of the satellite can be permitted is because it is such a minor experiment. If it were anything larger, i.e., a formal channel with any quantity of transmission, the approvals may be far more difficult to attain.

(Note: The alternative of moving from ATS-1 to leased common carrier channels at a later time was discussed under (2.1). The following discussion relates to a policy position for the use of ATS-1 for experimentation in the current period and near future).

(4.2) How can ATS-1 be used for near future experimentation without running into difficulty on the question of competition by the common carriers?

Dr. Singh commented that in January, 1973, NASA lost a major part of their communications program. This came about because private enterprise had reached the point where their satellite programs were capable of providing the services needed without additional initiative from the government.

As long as the project is undertaken on an experimental basis, no one will question NASA and NASA can clear it. The injection of the word "operational" or the indication that an operational phase has been entered is likely to be questioned, as the use of ATS-1 and ATS-3 were.

However, in pre-operational experimentation, ATS-1 is available and it should be noted that NASA is receptive to transfer-

ring the responsibility for ATS-1 to another organization. The reason is that it costs them over $1 million per year for operations and maintenance of the satellite.

Both Dr. Abramson and Dr. Kahn are involved in attempting to secure ATS-1 for use by ARPA. If the transfer is made to ARPA from NASA, ATS-1 will be available for additional experimentation.

Summary. The utilization of satellites in the Pacific Network experiments will come to the attention of administrators who are sensitive to the position of their agencies as non-competitors to private enterprise. To avoid conflict with the sponsoring agencies and the common carriers, the goals and intents of the project should always be stated as "experimental" and "educational" but never "operational."

## 5. INTERIM ORGANIZATION

The Pacific Education Computer Network experiments were of considerable interest to those attending the meeting, both on an immediate need and long-range planning basis. The need for continued information dissemination was expressed and a series of papers was defined as desirable material for distribution. These were: (1) a periodic newsletter of general interest, to be sent to participants and interested parties; (2) a general description of the plan for the development of the network, to be sent to participants and interested parties; and (3) working papers describing technical details, to be sent to those involved in constructing network connections.

Since the University of Hawaii was the most deeply involved in the satellite system experiments, it was agreed that Dr. Norman Abramson would be the formal editor of the newsletter and that the ALOHA System would bear the responsibility for the dissemination of the materials and other information relating to the Pacific Educational Computer Network experiment.

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Huskey, Harry D., Computer Needs and Computer Problems in Developing Countries, CN74-20

Oizumi, Juro, Plans for a Japanese University Computer Network, CN74-12

Sung, Ki Soo, A Perspective of the Pacific Computer Network in Korea, CN74-28

Vignaux, G.A., Educational Computing in New Zealand, CN74-30

Reports of Interest Available from THE ALOHA SYSTEM, University of Hawaii:

Abramson, Norman, The ALOHA System, B72-1

Kuo, Franklin F., and Abramson, Norman, Some Advances in Radio Communications for Computers, B73-1

Abramson, Norman, Packet Switching With Satellites, B73-2

Abramson, Norman, and Ah Mai, Karen, Pacific Educational Computer Network Study (Planning and Review Meeting, January 8, 1973), B73-3

Kuo, Franklin F., and Binder, Richard D., Computer-Communications by Satellite: The ALOHA System, B73-4

Abramson, Norman, Digital Broadcasting in Hawaii--The ALOHA System, B73-5

Wax, David W., Status Report on UH/ALOHA Participation in the ATS-1 Computer Communications Experiment, ASS Note 56, February 28, 1974

Kuo, Franklin F., Selected Papers on Computer-Communications Nets, B74-4

Ah Mai, Karen, Organizational Alternatives for a Pacific Educational Network, CN74-27

General Availability:

Subconference Proceedings on Computer Networks, Seventh Hawaii International Conference on System Sciences, Western Periodicals Company, 1974

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Any comments or contributions to the Pacific Educational Computer Network Study may be sent to:

University of Hawaii, The ALOHA System
PACIFIC EDUCATIONAL COMPUTER NETWORK STUDY
2540 Dole Street, Holmes Hall 486
Honolulu, Hawaii 96822 U.S.A.

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UNIVERSITY OF HAWAII
THE ALOHA SYSTEM
2540 Dole Street, Holmes 486
Honolulu, Hawaii 96822
USA

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[Selected papers presented at the Seventh Hawaii International Conference on System Sciences: Subconference on Computer Nets, January 7, 8, 9, 1974.]

- ☐ CN74-23: Ah Mai, Karen, Status of Computing in the Pacific.
- ☐ CN74-29: Bennett, John, Computers and Networking in the South Pacific.
- ☐ CN74-24: Chen, D.T.S. and Hwang, J.J., An Experimental Radio-Linked Computer Communication System in Taiwan.
- ☐ CN74-19: Djojodihardjo, H. and Mardiono, Harsono and Tunggal, Computer at Institut Teknologi Bandung: Progress and Problems.
- ☐ CN74-17: Dunn, D.A. and Eric, M.J., The Economics of Packet Switching.
- ☐ CN74-16: Fujita, K., Ikeda, T., Noguchi, S., Sato, R., Oizumi, J., Ebihara, Y., Kuo, F.F. and Abramson, N., A Japan-Hawaii Computer Net--Telex and Satellite.

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- ☐ CN74-20: Huskey, Harry D., Computer Needs and Computer Problems in Developing Countries.
- ☐ CN74-12: Oizumi, Juro, Plans for a Japanese University Computer Network.
- ☐ CN74-28: Sung, Ki Soo, A Perspective of the Pacific Computer Network in Korea.
- ☐ CN74-30: Vignaux, G.A., Educational Computing in New Zealand.

[Other reports of interest.]

- ☐ B72-1: Abramson, Norman, The ALOHA System, January 1972.
- ☐ B73-1: Kuo, Franklin F. and Abramson, Norman, Some Advances in Radio Communications for Computers, March 1973.
- ☐ B73-2: Abramson, Norman, Packet Switching with Satellites, March 1973.
- ☐ B73-3: Abramson, Norman and Ah Mai, Karen, Pacific Educational Computer Network Study (Planning and Review Meeting, January 8, 1973), May 1973.
- ☐ B73-4: Kuo, Franklin F. and Binder, Richard D., Computer-Communications by Satellite: The ALOHA System, August 1973.
- ☐ B73-5: Abramson, Norman, Digital Broadcasting in Hawaii -- The ALOHA System, November 1973.
- ☐ ASSN 56: Wax, David W., Status Report on UH/ALOHA Participation in the ATS-1 Computer Communications Experiment, February 28, 1974.

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- ☐ B74-4: Kuo, Franklin F., Selected Papers on Computer-Communications Nets, May 1974.
- ☐ CN74-27: Ah Mai, Karen, Organizational Alternatives for a Pacific Educational Network, May 1974.

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**Title:** PLANS FOR A JAPANESE UNIVERSITY COMPUTER NETWORK (CN74-12)

**Author:** Juro Oizumi

**Abstract:** At first, present status of large scale computer center of Japanese major universities is described, emphasizing TSS & RJE services. Then, after a brief survey on Japanese computer network studies, the national academic computer network project is explained. Date of publication: January 1974.

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**Title:** A JAPAN-HAWAII COMPUTER NET -- TELEX AND SATELLITE (CN74-16)

**Author:** Katsumi Fujita, Tetsuo Ikeda, Shoichi Noguchi, Risaburo Sato, Juro Oizumi, Yoshihiko Ebihara, Franklin F. Kuo, Norman Abramson

**Abstract:** Recently, the study on computer network has developed rapidly and its achievement have become a center of wide interest. In this paper, we describe a Japan-Hawaii computer network, a Telex link and a Telex-Satellite link. At present, the Telex link is used instead of the radio UP link for data-transmission because of the license in Japan. Date of publication: January 1974.

---

**Title:** THE ECONOMICS OF PACKET SWITCHING (CN74-17)

**Author:** D. A. Dunn and M. J. Eric

**Abstract:** Some of the economic factors in the design of packet-switched networks are discussed, including hardware costs as a function of technology and system performance. A comparison of illustrative costs for four alternative technological approaches to the design of the transmission system for a 100 node network is presented. The transmission technologies compared are: (1) circuit-switched land line; (2) packet-switched land line; (3) broadcast-mode satellite-based, with earth stations serving groups of nodes; and (4) broadcast-mode satellite-based, with an earth station at every node. A brief discussion is given of regulatory limitations on the choice of hardware options and the relationship between the cost structure and network pricing policy. Date of publication: January 1974.

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**Title:** COMPUTER AT INSTITUT TEKNOLOGI BANDUNG: PROGRESS AND PROBLEMS (CN74-19)

**Author:** Harijono Djojodihardjo, Harsono and Tunggal Mardiono

**Abstract:** With the assignment of Bandung Institute of Technology (ITB) as one of five major universities to be developed into centers of excellence in Indonesia, and reiteration of its basic philosophy as being development oriented and development committed, the computer center was established in 1972. In this connection, activities of the computer center are directed toward serving education, research and public service. Attempts have been made to develop manpower, software as well as hardware capabilities, and to initiate future studies in computer science. Progress and development toward this goal is outlined. The possibility of ITB to join the Pacific Education Computer Network is discussed. Date of publication: January 1974.

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**Title:** COMPUTER NEEDS AND COMPUTER PROBLEMS IN DEVELOPING COUNTRIES (CN74-20)

**Author:** Harry D. Huskey

**Abstract:** This paper surveys the computer environment in a developing country. Levels of development are considered and the educational requirements of countries at various levels are discussed. Computer activities in India, Burma, Pakistan, Brazil and a United Nations sponsored educational center in Hungary are all described. Date of publication: January 1974.

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**Title:** THE STATUS OF COMPUTING IN THE PACIFIC (CN74-23)

**Author:** Karen Ah Mai

**Abstract:** Educational computing in the Pacific includes a diversity of capability, ranging from initial attempts to sophisticated multi-processor operations. A study of

educationally-oriented computing capability in the Pacific Rim nations indicates that interest and capabilities exist for further study into a computer-communications development with the objective of sharing the educational resources of the Pacific region. Date of publication: January 1974.

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Title: AN EXPERIMENTAL RADIO-LINKED COMPUTER COMMUNICATION SYSTEM IN TAIWAN (CN74-24)

Author: D. T. S. Chen and J. J. Hwang

Abstract: In this paper, we describe an experimental UHF radio-linked computer communication system which is now under development in north Taiwan area connecting the computing centers of National Taiwan University, National Chiao-Tung University and Telecommunication Laboratories. Because of mountain obstacles and our research interest, the radio link is operated in diffraction mode instead of using repeaters. In addition to the presentation of the system description and updating experimental results, we will also describe the present status of computer utilization and data transmission services in Taiwan in order to have a look into the future extension of the system. Date of publication: January 1974.

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Title: A PERSPECTIVE OF THE PACIFIC COMPUTER NETWORK IN KOREA (CN74-28)

Author: Ki Soo Sung

Abstract: Advances in computers and computer networking in Korea are described. The efforts of the Korea Institute of Science and Technology (KIST) have been instrumental in the rapid development of the governmental, educational, and commercial computer networks. Transpacific linkages have been attempted but have experienced legal rather than technical difficulties. Communications are provided by domestic telephone service. A TELEX connection is being studied and a Pacific Computer Network for education and research is being looked forward to. Date of publication: January 1974.

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Title: COMPUTERS AND NETWORKING IN THE SOUTH PACIFIC (CN74-29)

Author: John M. Bennett

Abstract: Some basic statistics of the South Pacific are summarized, with particular references to current and possible future computer usage for education and research. The patterns of communication links and Australian communication developments, current and future, are discussed, as are networks being developed for education and research in Australia. Date of publication: January 1974.

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Title: EDUCATIONAL COMPUTING IN NEW ZEALAND (CN74-30)

Author: G. A. Vignaux

Abstract: This note sets out briefly the present situation of educational computing in New Zealand with particular reference to computing education and networking capability. Date of publication: January 1974.

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Title: THE ALOHA SYSTEM (B7?-1)

Author: Norman Abramson

Abstract: This report provides a status report and description of THE ALOHA SYSTEM research project at the University of Hawaii. THE ALOHA SYSTEM involves the analysis and construction of advanced methods of random access communications in large computer-communication systems.

The existing ALOHA SYSTEM computer-communication network uses two 24,000 baud channels in the UHF band. The system employs message switching techniques similar to those of the ARPANET, in conjunction with a novel form of random access radio channel multiplexing. By means of these techniques the system has the capacity to accommodate several hundred active users of alphanumeric consoles on the two channels available. Each of these users can transmit and receive at a peak data rate of 24,000 baud although the average data rate of the users must of course be considerably less.

In June 1971 the central UHF station of THE ALOHA SYSTEM had been built and tested by the first radio linked remote terminal. By the end of 1971, four remote terminals had been connected to the 360 through THE ALOHA SYSTEM central station and the design and construction of new forms of UHF links for intelligent terminals, minicomputers and RJE stations was in progress. Present plans are to continue adding new forms of remote links and to continue a program of upgrading the capabilities of the existing central station through the summer of 1972. At that time the existing design will be frozen and a period of experimental operational use of a statewide radio linked computer-communication network will begin. Date of publication: January 1972.

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Title: SOME ADVANCES IN RADIO COMMUNICATIONS FOR COMPUTERS (B73-1)

Author: Franklin F. Kuo and Norman Abramson

Abstract: In this paper we describe an experimental UHF radio computer communication network - THE ALOHA SYSTEM - under development for the past five years at the University of Hawaii [1]. Presently in operation on an experimental basis, the existing ALOHA SYSTEM computer-communication network uses two 24,000 baud channels at 407.350 MHz and at 413.475 MHz in the upper UHF band. The system uses packet switching techniques similar to that employed by the ARPANET [2], in conjunction with a novel form of random-access radio channel multiplexing. Recently THE ALOHA SYSTEM has become the first satellite node on the ARPANET, in which a TIP (Terminal Interface Processor) [3] located at the University of Hawaii campus communicates through a 50 kilobit data channel using INTELSAT IV with the NASA/AMES TIP and into ARPANET. The 50 kilobit satellite channel occupies a single PCM voice channel on INTELSAT IV. We will describe some of our current activities in this paper and present a look into the future of our project. Date of publication: March 1973.

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Title: PACKET SWITCHING WITH SATELLITES (B73-2)

Author: Norman Abramson

Abstract: The beginning of the 1970's has witnessed the establishment of new forms of computer-communication networks, with clear advantages over the voice oriented point-to-point, channel switched networks of the 1960's. This paper describes some of the most important properties of these new networks -- packet switching, bilateral broadcasting and burst random access capabilities. The advent of easily available, inexpensive satellite communications gives added importance to these properties and promises added capabilities for computer-communication networks of the future. In this paper we provide a theoretical framework from which we can derive the capacity, delay and average power of these new forms of communication. Finally we describe how these forms of communication might be employed in some of the planned US domestic satellite systems to provide a public packet switched service. Date of publication: March 1973.

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Title: PACIFIC EDUCATIONAL COMPUTER NETWORK STUDY (B73-3)
(Planning and Review Meeting, January 8, 1973)

Author: Norman Abramson and Karen Ah Mai

Abstract: The first planning meeting for a Pacific Educational Computer Network was held at the University of Hawaii, Honolulu, Hawaii, on January 8, 1973. Professor Norman Abramson of the University of Hawaii and Professor Juro Oizumi of Tohoku University, Japan, co-directors of the network feasibility study, hosted the meeting. Topics discussed were the status of computing in the Pacific, the technology of a Pacific network, the economics and technology of such a network, and alternatives in planning a Pacific Educational Computer Network. Date of publication: May 1973.

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Title: COMPUTER-COMMUNICATIONS BY RADIO AND SATELLITE: THE ALOHA SYSTEM (B73-4)

Author: Franklin F. Kuo and Richard D. Binder

Abstract: In this paper we describe an experimental UHF radio computer communication network - THE ALOHA SYSTEM - under development for the past five years at the University of Hawaii. Presently in operation on an experimental basis, the existing ALOHA SYSTEM computer-communication network uses two 24,000 baud channels at 407.350 MHz and at 413.475 MHz in the upper UHF band. The system uses packet switching techniques

similar to that employed by the ARPANET, in conjunction with a novel form of random-access radio channel multiplexing. Recently THE ALOHA SYSTEM has become the first satellite node on the ARPANET, in which a TIP (Terminal Interface Processor) located at the University of Hawaii Manoa Campus communicates through a 50 kilobit data channel using INTELSAT IV with the NASA/AMES TIP and into the ARPANET. The 50 kilobit satellite channel occupies a single PCM voice channel on INTELSAT IV.

Our current activities are concentrated on two major areas -- radio and satellite. In the radio area, we are presently developing a Phase II ALOHA SYSTEM with minicomputers used as programmable terminals and repeaters. In the satellite area we are working on a project involving the NASA satellite ATS-1 with small inexpensive ground stations. This study is linked to another ALOHA SYSTEM project -- that of a feasibility study of a Pacific Educational Computer Network (PACNET) to link computers in developed countries and developing countries in the Pacific. Date of publication: August 1973.

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**Title:** DIGITAL BROADCASTING IN HAWAII - THE ALOHA SYSTEM (B73-5)

**Author:** Norman Abramson

**Abstract:** At the present time conventional methods of remote access to a large information processing system are limited to point-to-point wire communications--either leased lines or dial-up telephone connections. In some situations these alternatives provide adequate capabilities for the designer of a computer-communication system. In other situations however the limitations imposed by point-to-point wire communications restrict the usefulness of remote access computing. In THE ALOHA SYSTEM research project at the University of Hawaii we have developed and built a computer-communication network based upon the use of UHF radio broadcast channels for console to computer and computer to computer communications. The novel communications architecture of this ground based network employs the packet switching techniques of the ARPANET together with a random access broadcasting technique well suited to the communication needs of a computer network. These new concepts are also employed in two satellite networks (employing INTELSAT IV and ATS-1) which are joined in a multi-network "gateway" at THE ALOHA SYSTEM MENEHUNE (multiplexor). Date of publication: November 1973.

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**Title:** SELECTED PAPERS ON COMPUTER-COMMUNICATION NETS (B74-4)

**Author:** Franklin F. Kuo

**Abstract:** This report consists of three papers written by Franklin F. Kuo, (Director, THE ALOHA SYSTEM, University of Hawaii) on computer-communication nets. ON PACKET COMPUTER-COMMUNICATION NETWORKS examines the structure of packet switched communication networks, which are designed to permit the statistical sharing of high speed communication lines by many users and are much better suited for computer communication applications than circuit switched networks. POLITICAL AND ECONOMIC ISSUES FOR INTERNETWORK CONNECTIONS attempts to outline some of the political and economic issues which must be addressed before meaningful network interconnections can come about. The issues discussed are: bilateral versus multilateral agreements, standards, the viewpoint of the common carriers, network accounting, tariffs and excises, privacy and security. The main purpose is to present the problems and issues but not to offer any solutions. In THE ALOHA BROADCAST PACKET COMMUNICATION SYSTEMS a general overview of the importance of packet communications to computer-communication networks is presented. A discussion of what packet broadcasting is and a detailed description of the ALOHA packet radio network as an illustration of packet broadcasting follows. Finally some present efforts on packet satellite systems are described. Date of publication: May 1974.

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**Title:** STATUS REPORT ON UH/ALOHA PARTICIPATION IN THE ATS-1 COMPUTER COMMUNICATIONS EXPERIMENT (ASSN 56)

**Author:** David W. Wax

**Abstract:** In January, 1972, the Spacecraft Data Systems Branch of the Ames Research Center, NASA, initiated an experiment in Computer Communications via the ATS-1 geosynchronous satellite. This experiment is designed to demonstrate the feasibility of utilizing satellite communication links to provide computer-computer and terminal-computer communications between remotely located sites. In order that the experiment be conducted under realistic conditions, computing facilities at the University of Hawaii (UH) and the University of Alaska (UA) are being connected

to the Advanced Research Projects Agency (ARPA) computer net via an ATS-1 VHF link to the NASA - Ames Research Center (ARC). The ATS-1 VHF transponder is being utilized as a broadcast repeater for the three above-mentioned nodes, with the satellite network operating in the ALOHA random-access burst mode. This report gives the status of this experiment. Date of publication: February 28, 1974.

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**Title:** ORGANIZATIONAL ALTERNATIVES FOR A PACIFIC EDUCATIONAL NETWORK (CN74-27)

**Author:** Karen Ah Mai

**Abstract:** The purpose of this paper is to provide a general background for the development of computer-communication networks for the non-technical reader. The specific focus is on establishing a foundation for considering the organizational problems of educational computer-communications network development in the Pacific Rim.

To provide some background for the consideration of networks, several networks concentrating on network technology as well as several concentrating on network applications are discussed. Important points of network development and operating organization are analyzed.

Background for international development is then discussed to enlarge the focus from U.S. experiences to the international environment. In this regard, some basic assumptions on the international environment and the results of an interest and capabilities survey for such a network within the Pacific Rim are discussed.

Finally, the requirements, issues, and alternatives involved in international network development are covered. Though the focus is on the Pacific Educational Computer Network, many of the points are universally applicable to network administrative development. To be published.